

1 Work Environment Noise Levels and Risk Locations in Two 2 Selected Commercial Areas in Ibadan, Nigeria

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5 *Received: 10 December 2012 Accepted: 4 January 2013 Published: 15 January 2013*

6

7 **Abstract**

8 Introduction: The increasing use of electric generators in small scale businesses is predicated
9 on the erratic and inadequate power supply in Nigeria. We assessed the work environment
10 noise levels and developed a risk map for noise in two commercial locations Methods: Noise
11 levels in A-weighted decibels (dBA) were measured over 12 weeks in 3 months at three times
12 of the day (8am-10am, 11am-1pm and 3pm-6pm) using a calibrated sound level meter
13 approximately 5 meters from sources. A geographical positioning system (GPS) was used to
14 determine the coordinates of sampling points. Risk areas were defined thus; High risk [80-90
15 dB (A)], medium risk [70-80 dB (A)] and low risk [60-70 dB (A)] respectively. Results: The
16 highest mean noise levels in Agbowo (93.7 dB) and Ajibode (90.3 dB) was obtained around
17 11am-1pm on Wednesday and Saturday respectively. In Agbowo; Enclosed location had the
18 highest mean noise level (98.7dBA) as compared to road side location in Ajibode (81.7dBA).

19

20 **Index terms**— noise pollution, electric generators, work environment.

21 **1 Introduction**

22 Noise is derived from the Latin term *nausea*. It is an inescapable part of everyday life and can be defined by various
23 ways, but essentially it can be described as "wrong sound, in the wrong place at the wrong time" (Thompson,
24 1994). A major distinction between sound and noise is that sound is regarded as noise when it becomes a source
25 of inconvenience to another individual. Noise is a number of tonal components disagreeable to man and more or
26 less intolerable to him because of the discomfort, fatigue, disturbances and, in some cases, pain it cause (Singh
27 and Davar, 2004).

28 Noise originates from human activities, especially during urbanization and the development of transport and
29 industry. Noise is becoming an increasingly omnipresent, yet unnoticed form of pollution even in developed
30 countries. According to Brigitte and Lindvall (1995), road traffic, construction equipment, manufacturing
31 processes, and lawn mowers are some of the major sources of these unwanted sounds that are routinely broadcasted
32 into the air.

33 Increase in vehicular traffic is a source of noise pollution around the globe especially in most urban cities around
34 the world. Traffic related noise pollution accounts for nearly two-third of the total noise pollution in an urban
35 area (Birgitta and Lindvall, 1995), other sources include jet planes, garbage trucks, construction equipments,
36 manufacturing processes and lawn mowers. Any sound which is annoying or level of sound exceeds 75 dB (A)
37 may be conceived as noise. The threshold for noise annoyance varies. It depends on the conditions, including
38 the sensitivity and mental state of an individual (Mokhtar et al., 2007). Generally, noise can create negative
39 emotions, feeling of surprise, frustration, anger and fear.

40 According to Maduemezia (2002), noise pollution is one aspect of environmental pollution that is taken rather
41 lightly in Nigeria. He asserted that greater part of the sources of noise in the society is of a social origin. However,
42 noise, as a polluting agent in the environment, has been recognized in recent years as a serious threat to the
43 quality of life enjoyed by people in most industrialized nations (FTA, 1995). In developing nations, however,

6 D) SURVEY

44 noise pollution has not been seen as dangerous and having adverse effect on the life of the people (Abumere
45 et al., 1999). This is probably the reason why not much research into environmental noise pollution has been
46 carried out within Nigeria cities.

47 Electric energy occupies the top grade in energy hierarchy as it finds innumerable uses in homes, industry,
48 agriculture, and defense and of course in some nations, transportation. Nigeria's electricity power situation is
49 very poor because of erratic power supply. As a result there is an upsurge in the use of electricity generating plant
50 with its attendant noise pollution on the environment and human health ??Akande and Olonge, 2001). Most
51 workplaces and homes use generating plants 24 hours in alternative to power supply. The noise from generated
52 plants in Nigeria coupled with its accompanying smoke emission to the sky which has greatly contributed to the
53 breaking of the ozone layer in the sky ??Deepak, 2009).

54 Occupational noise is considered to be a major cause of adult-onset hearing loss worldwide (Nelson, 2005).
55 Workers across the world are at risk of hearing loss due to the presence of a high level of noise at their workplaces
56 (Verbeek et al., 2009). In USA, more than 30 million workers (almost 1 in 10) are exposed to unsafe noise
57 levels on the job ??McReynolds, 2005). In Europe, about 35 million people are exposed to detrimental noise
58 levels (> 85 dB-A) in industrial plants ??Sulkowski et al., 2004). A recent study in Nigeria reported high levels
59 of occupational noise (>90dB) among traders and 100% of workers exposed for a period of 14 years developed
60 hearing impairment (Ighoroje et al., 2004 andBisong et al., 2004).

61 However, the Federal government of Nigeria formed the Federal Environmental Protection Agency (FEPA)
62 back in 1990 and entrusted it with the responsibility of law formulation, control and regulate impact of noise in
63 the country (FEPA, 1991). Unfortunately, the impact of FEPA is yet to be felt (Onuu, 1999). Very few reports
64 of noise pollution studies are available in Nigeria. This study is considered necessary because it would allow a
65 comparison of the measured levels with known levels already considered safe for man according to WHO guideline
66 limit. According to this guideline, the recommended noise levels in commercial environment should be 65-70 dB
67 (A).

68 Therefore, an assessment of the work environment noise levels and development of risk map for noise in these
69 commercial locations would help focus future government interventions in the area of noise abatement in these
70 areas. Furthermore, it would serve as information for people working in these areas so as to take necessary
71 precaution towards protecting themselves from the adverse effect of noise II.

72 2 Materials and Methods

73 This study was conducted in Agbowo and Ajibode business areas of Ibadan, Nigeria after proper compulsory
74 ethical review by the University of Ibadan (UI) and University College Hospital (UCH) Ethical review committee,
75 Ibadan. Participants in these business locations were duly informed and consent was obtained. This study also
76 went through proper required institutional review board procedures at the College of Medicine, University of
77 Ibadan prior to its initiation.

78 3 a) Study Design

79 A comparative cross-sectional design was used which involved repeated field measurements of environmental noise
80 levels at specific recorded geographical coordinates and the development of risk map for noise using the google
81 earth software package.

82 4 b) Study Area

83 Agbowo and Ajibode are both located in Ibadan, the capital of Oyo State in Nigeria. Ibadan, one of the largest
84 metropolitan cities in West Africa, is a primarily indigenous city with millions of inhabitants, most of which
85 are Yoruba; other ethnic groups constitute smaller proportions of the population. The Agbowo business area
86 is situated directly opposite the University of Ibadan and is a high commercial activity area encouraging small
87 scale businesses (Tomori, 2006). The Ajibode business area is also at close proximity to the University of Ibadan
88 campus, but experiences relatively lower daily business activity.

89 5 c) Study Site

90 The shops in Agbowo and Ajibode were each classified into three similar study sites based on the nature of the
91 surrounding environment, they include; enclosed shops (EC), roadside shops (RSS) and single street shops (SSS).
92 This was done to ensure that noise all other environmental noise sources were put into consideration.

93 6 d) Survey

94 An observational checklist was used to collect data on other environmental noise sources located outdoors and
95 indoors in the classified locations as stated above. Information on the number of shops and workers were also
96 obtained using the observational checklist. (Data not reported).

97 7 e) Traffic Density Estimation

98 This was obtained by manually counting the number of vehicles every 15 minutes within a one hour time interval
99 between 6-8am, 11am-1pm, and 4-6pm. The obtained number is then multiplied by 4 to obtain the hourly traffic
100 density. Information on the types of automobiles observed in Agbowo and Ajibode were also noted.

101 8 f) Noise Measurements

102 The environmental noise levels in the classified locations were measured using a factory calibrated TECPEL Model
103 330 series sound level meter (SLM), which was set at the slow response mode with Aweighting (A-weighted decibels
104 or dBA). Measurements obtained was compared with the International norms (WHO recommended sound levels)
105 . Measurements were obtained at three sampling points outdoors (identified hereafter as L1, L2, and L3) within
106 each of the surveyed business locations. Three complete sets of sound level measurements were taken: ? One
107 complete set of measurement before the start of commercial activity (6-8am). ? One complete set of measurement
108 at the peak of commercial activity (11am -1pm). ? One complete set of measurement at the close of commercial
109 activity (4-6pm).

110 i. Frequency of Noise Measurements Noise readings were obtained at 10 minute Intervals. The outdoor noise
111 level measurement was carried out for three days weekly for a period of three months for both groups. Noise
112 levels were obtained from sampling points L1, L2 and L3 on Monday, Wednesday and Saturday.

113 ii. Noise Measurement at Worker Position A noise assessment form was used to obtain information on the
114 hours spent at work as well as the noise level at the position of worker. A sound meter was positioned at 10 and
115 30cm from the worker's ear to obtain the actual noise level filtering into the ear. The sound level meter was set
116 at slow and measurements were done in A-weighting scale. The noise levels obtained at 10cm and 30cm were
117 summed and the average was obtained as the mean noise level at which the worker was exposed to at work.

118 9 g) Development of Risk Map for Noise in the Classified 119 Business Locations

120 A hand-held, battery-powered factory calibrated gamin GPS was used to determine the geographic coordinates
121 of the sampling points in classified locations in Agbowo (AG1-AG3) and Ajibode (AJ1-AJ3) for noise level
122 assessment. The coordinates of the locations which appeared on the display screen of the GPS after signal is
123 acquired from the satellite in space were recorded and then inserted into a Google Earth Software package to
124 develop the risk map. The risk map was interpreted based on the mean noise level measured for each of the
125 classified commercial locations in Agbowo (AG1, AG2 and AG3) and Ajibode (AJ1, AJ2 and AJ3).

126 10 High Risk

127 11 Results

128 12 a) Identified Environmental Noise Sources

129 In Ajibode, all three classified locations (AJ1-3) recorded low number of generators as compared to Agbowo where
130 AG1 and AG2 recorded the presence of greater than 25 generators. Other noise sources such as music recording
131 houses, automobile and motorcycles and religious centres showed variation in their numbers across the classified
132 locations in Agbowo and Ajibode commercial areas. See table ?? The workers at Agbowo were exposed to mean
133 noise level of 81.0dBA which exceeded the WHO guideline limit of 70dBA. The maximum and minimum values
134 ranged from 63.6 dB(A) to 99.2 dB(A). In Ajibode, workers were exposed to mean noise level of 62.5 dBA which
135 was below the WHO guideline limit of 70dBA. The maximum and minimum values ranged from 60.0 dB(A) to
136 82.7 dB(A). The mean hour at work in Agbowo was 5.5 ± 1.7 hours as compared to 2.1 ± 1.1 hours in Ajibode.
137 See Table ?? IV.

138 13 Discussion

139 The high numbers of environmental noise sources such as electric generator, cars, music houses and motorcycles
140 observed in Agbowo location as compared with Ajibode is predicated on the increased level of commercial
141 activities present in this area. A similar study on environmental noise within Delta state campus, Nigeria
142 conducted by (Oseji, 2011) revealed heavy noise pollution during business activities and attributed this to the
143 indiscriminate use of electric generators. Another study conducted by (Omubo -Pepple, 2010) in Nigeria revealed
144 that the main noise pollution sources in Port Harcourt metropolis came from generators, road traffic and the use
145 of loudspeakers mainly in religious and social gatherings. Frequent power failure has resulted in proliferation of
146 electric generators in Agbowo, hence urgent government intervention and health education is required to employ
147 noise control strategies.

148 Traffic Density in Agbowo significantly exceeded those in Ajibode. The noise from vehicles may be termed road
149 traffic noise. Suter, 1991 identified the principal noise sources in a vehicle as the power unit and its auxillaries,
150 transmission system, tires and braking system. This may have contributed to the high level of noise observed in
151 Agbowo as compared with Ajibode due to the increased presence of automobiles.

15 A) COMPETING INTEREST

152 The highest noise level measured in both Agbowo and Ajibode was around 11am -1pm, which was above the
153 WHO guideline limit of 70dB (A) for a commercial environment. This may not be unconnected with the fact that
154 respondents have the highest level of patronage and majority of the generators are in operation around that time
155 frame. In addition, Agbowo and Ajibode are close to traffic prone areas, which could contribute to the overall
156 noise levels. Yusoff and Karim (1997) revealed high noise level (104.3 dB) emanating from vehicular traffic.

157 High noise level in enclosed location in Agbowo exceeded those recorded in Ajibode and other classified
158 locations (Roadside and Street). Suter (1991) suggested that narrow streets and tall buildings can augment noise
159 and produce a "canyon" in which traffic noise or any other type of noise reverberates. Therefore the the nature
160 of the environment and surrounding buildings may be responsible for the overall noise levels measured in this
161 location.

162 The risk map showed that noise levels were significantly different in all classified locations. High risk areas
163 were represented by enclosed and road side locations in Agbowo and Ajibode respectively. The noise levels within
164 this location is between 80-90 dBA, which is capable of inducing hearing impairment ??WHO, 1993). This is not
165 surprising considering the fact that traffic noise (Suter, 1991) and electric generators in operation (Makinde et al.,
166 2008) produce heavy noise pollution which significantly contributes to the overall work environment noise levels.
167 This calls for urgent government intervention in the area of health education of workers on the hazards of noise
168 exposure. Low risk areas in Agbowo (street location) and Ajibode (enclosed location) were characterized by noise
169 levels between 60-70 dBA. Individuals within such location are at low risk of developing hearing impairment,
170 because its still within the guideline limit set by ??WHO, 1993).

171 Workers in Agbowo were exposed to mean noise levels of 81.0 dBA which ranged from (63.5 dBA to 99.2
172 dBA) as compared with their counterparts in Ajibode 62.5 dBA which ranged from (60.0 dBA to 82.7 dBA).
173 The workers in Agbowo generally work for 5.5 ± 1.7 hr/day as compared to 2.1 ± 1.1 hr/day in Ajibode. Therefore
174 they are both exposed over 36 hr/wk to high noise levels. The noise exposure levels in Agbowo are excessively
175 high as compared to the maximum permissible noise exposure limit of 85-90 dB(A) for 40h/wk as suggested by
176 ??SO, 1971. This high level of noise interferes with communication between workers, and prolonged exposure
177 could lead to hearing impairment.

178 V.

179 14 Conclusion

180 In this study, we described the level of noise pollution in selected/classified business locations. Environmental
181 noise sources such as generators, automobiles (traffic) and music shops were observed to be higher in Agbowo as
182 compared to Ajibode, this may have contributed to the overall noise levels observed in Agbowo as the mean noise
183 levels in Agbowo were found to be significantly higher than the WHO guideline limit of 70 dB(A) for commercial
184 work environment. High risk areas as described by the risk map were enclosed and roadside locations in Agbowo
185 and Ajibode respectively. These areas were characterized by noise levels within 80-90 dB(A). The workforce in
186 these locations are at high risk of developing noise induced hearing loss (NIHL) and other associated ailments
187 due to excessive noise exposure.

188 Therefore there is an urgent need for the government to design and implement a well defined, comprehensive
189 and enforceable noise regulation. In Nigeria, total working hours per week are around about 20% more than those
190 in USA or European countries (Olayinka, 2009), therefore the limit of 90 dB(A) for 8 h/d stated by OSHA and
191 Nigerian factories Act (FEPA, 1991) has to be followed with caution. Furthermore, workers in these locations
192 need to be provided with personal safety devices such as ear plugs or ear muffs. Position of worker at work is
193 also important as surrounding surfaces need to be covered with sound absorbent material e.g glass. Enclosure of
194 power generating sets would provide more attenuation than leaving it exposed.

195 15 a) Competing interest

196 The authors declare that they have no ^{1 2 3 4}

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Figure 1:

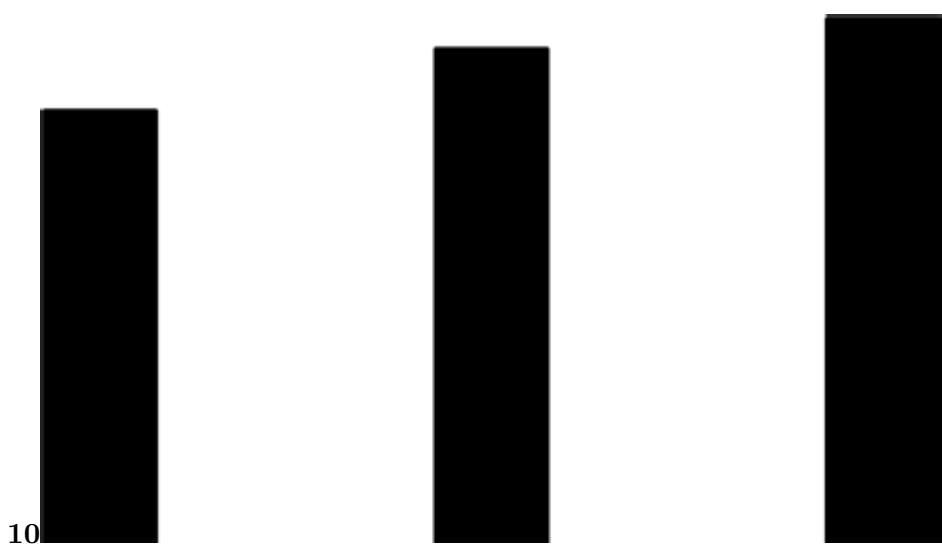


Figure 2: Figure 1 . 0 :



Figure 3: Figure 2 .Figure 5 . 0 :

1

c) Noise Measurements

The mean noise level in Agbowo was 78.5 ± 3.9 dB (A) which significantly exceeded the WHO standard (60-70 dBA) as compared to the mean noise level in Ajibode 65.7 ± 4.4 dB (A).

i. Daily Noise Levels

At 6-8am; the highest mean noise levels recorded in Agbowo (70.5dBA) and Ajibode (60.8dBA) were obtained on Saturday and Wednesday respectively. At 11am-1pm; the highest mean noise levels recorded in Agbowo (93.7 dB) and Ajibode (90.3 dB) were obtained on Wednesday and Saturday respectively. At 4-6pm; the highest mean noise levels recorded in Agbowo (80.8 dBA) and Ajibode (82.8 dBA) were both obtained on Wednesday. See Figures 3.1, 3.2 and 3.3

ii. Noise Levels per Location

In Agbowo; Enclosed location had the highest mean noise level (98.7dBA) as compared to roadside (80.4dBA) and street (69.2dBA) locations. In Ajibode; Roadside location had the highest mean noise level of 81.7dBA as compared to Enclosed (98.7dBA) and Street (72.8dBA) locations. See figure 3.4 for details.

Figure 4: Table 1 .

33

Classified Sampling Locations

Encl os ed
Locati on
Roads i
de Locati
on Street
Locati on

Business Area Agbowo Ajibode e) Risk Map for Noise The global Positioning system(GPS) facility was Noise

[Note: AgbowoPlate 1 and 2: Risk Map for Generator Users in Agbowo & Ajibode Commercial Environment]

Figure 5: . 3 Table 3 .

4

Business Area	Classified Sampling Points	Longitude (° N)	Latitude (° E)	Elevation (m)
Agbowo	AG1	7°26'27.00"N	3°54'26.35"E	783
	EC1	7°26'25.17"N	3°54'26.42"E	613
	EC2	7°26'23.81"N	3°54'26.92"E	692
	EC3	7°26'25.30"N	3°54'28.25"E	759
	EC4	7°26'27.38"N	3°54'28.34"E	680
	EC5	7°26'29.27"N	3°54'25.36"E	675
AG2	RSS1	7°26'30.78"N	3°54'25.33"E	613
	RSS2			

Figure 6: Table 4 .

15 A) COMPETING INTEREST

197 .1 Acknowledgement

198 We want to thank all respondents and research assistants who participated in this study. We are grateful to the
199 University of Ibadan who provided official approval for this study. I am particularly grateful to Captain & Mrs
200 Umoru Yesufu for their financial support.

201 Conflict of Interest: None to declare.

202 VI.

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